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GB 2279745 A GB 2272819 A GB 2160321 A
GB 1565258 A

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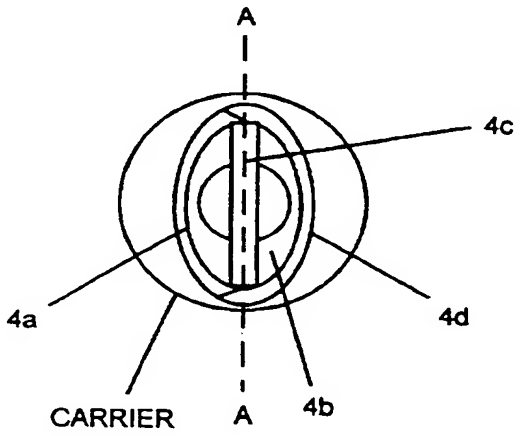
INT CL[6] G01S 15/93 , G10K 11/00 11/02 11/26 11/28
ONLINE; WPI, JAPIO, CLAIMS

(54) Ultrasonic object detection system for a vehicle

(57) The detection system uses ultrasonic transducers mounted within rotatable, ball-and-socket carriers (fig. 3) that have an oval aperture to produce a wide but flat beam capable of covering the width of the vehicle.

The system may be calibrated by turning two such transducers towards each other and measuring their separation.

Alarm signals in the form of pulsed audio tones may be used to represent obstacles in respective zones around the vehicle.



FRONT VIEW OF CARRIER

FIGURE 4

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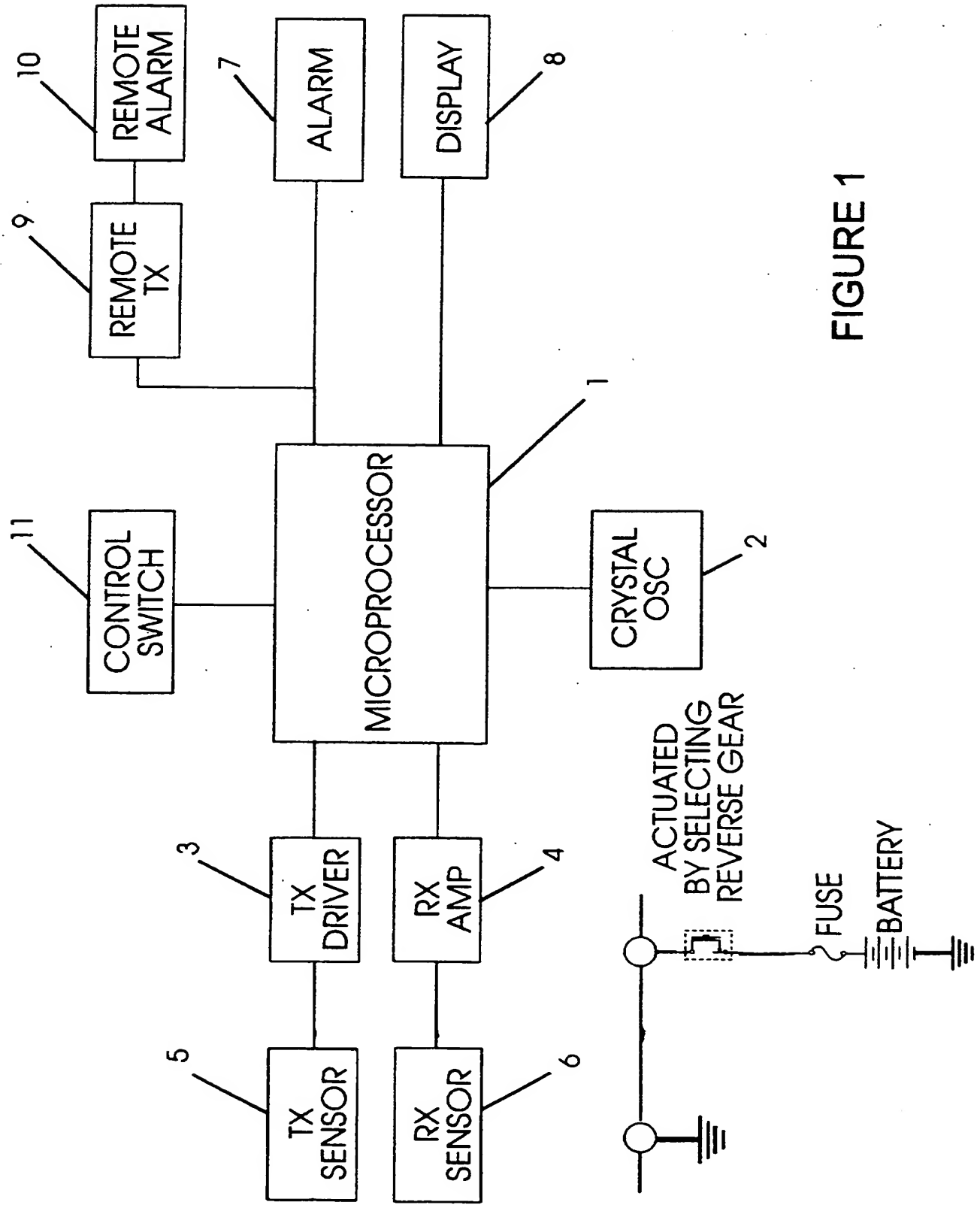

FIGURE 1

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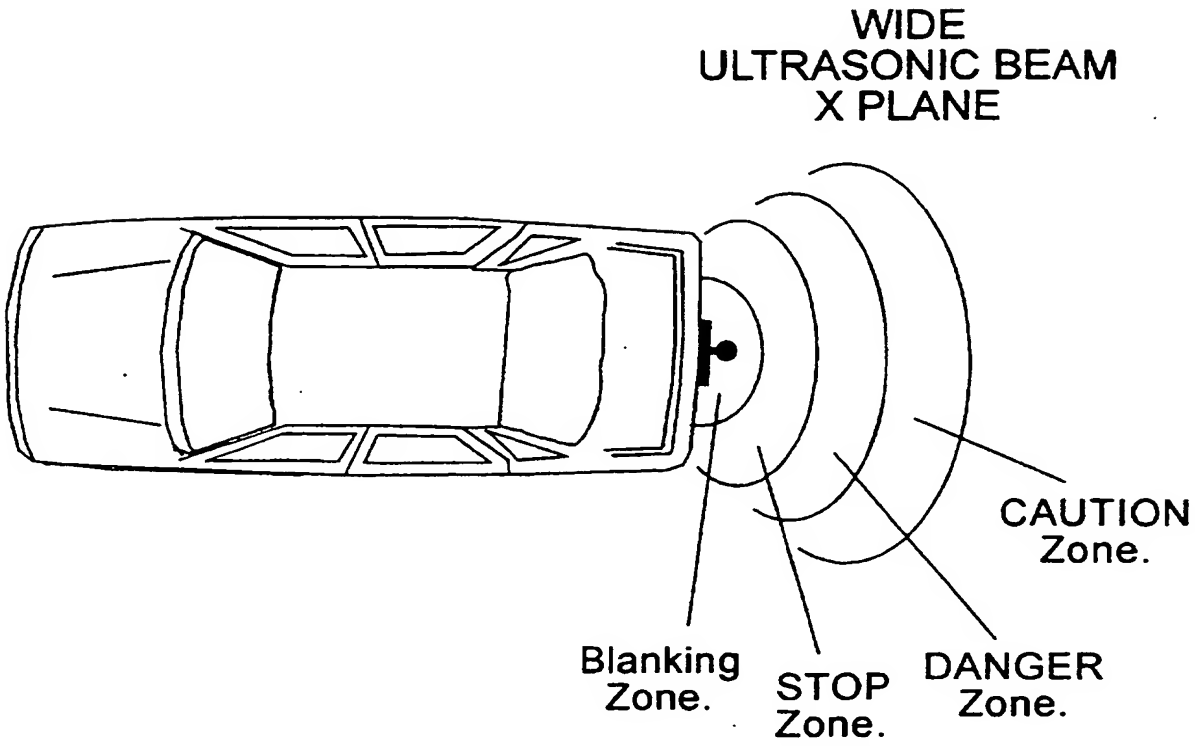


Blanking Zone - No objects are detected in this area,this allows the system to function even if towbars, towhooks or steps are fitted to the vehicle.

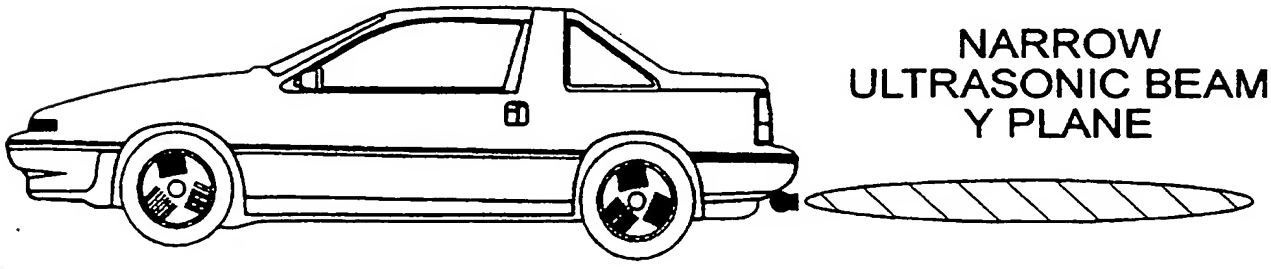
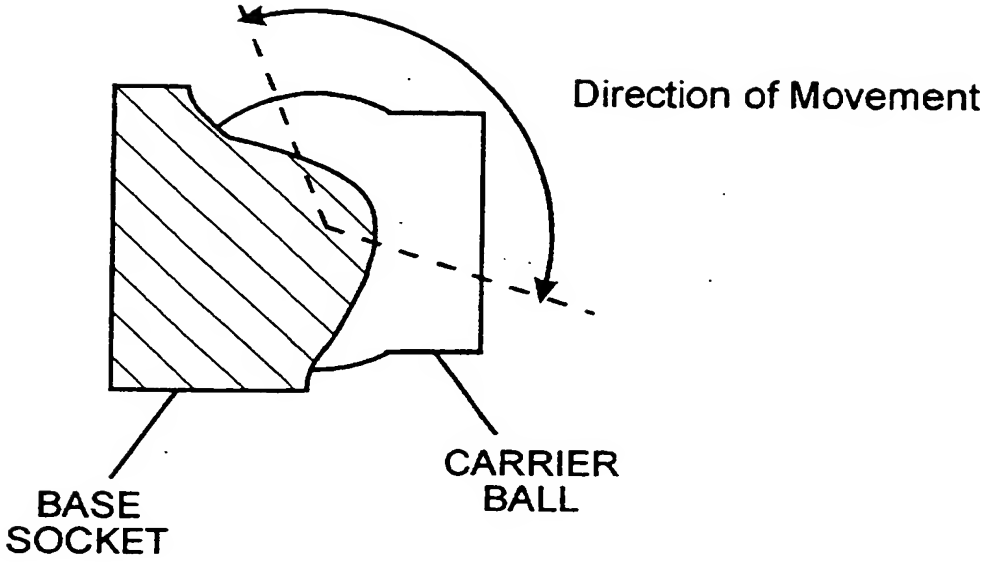
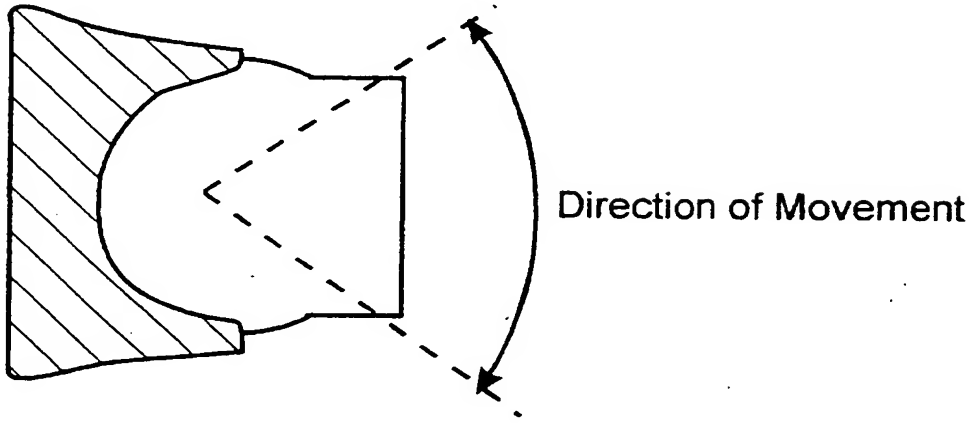


FIGURE 2



SIDE ELEVATION



PLAN ELEVATION

FIGURE 3

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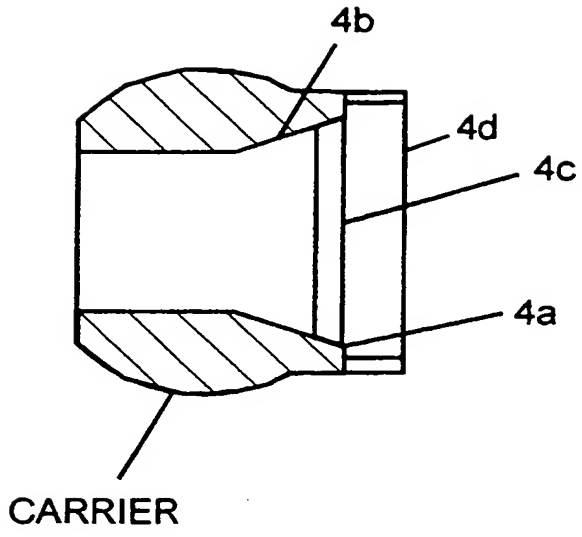
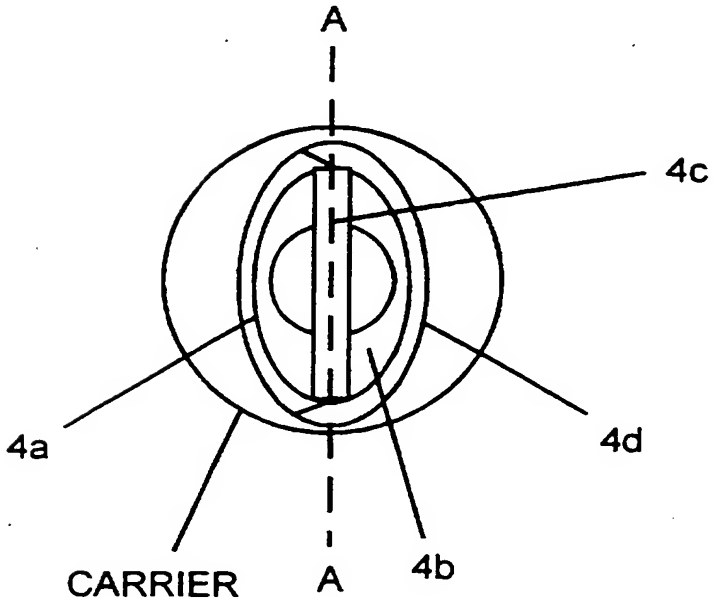


SECTION AA



FRONT VIEW OF CARRIER

FIGURE 4

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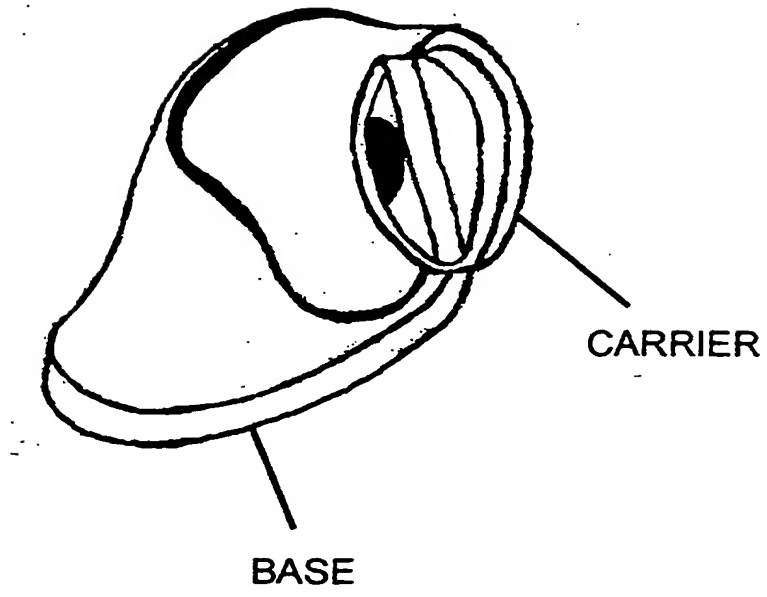
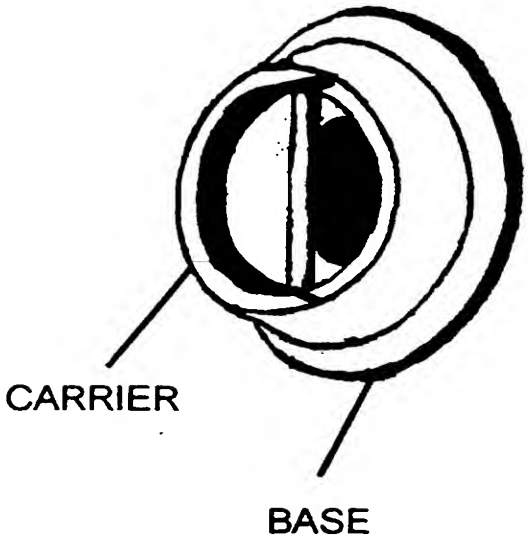


CARRIER & BASE
SURFACE MOUNTED ON
VEHICLE BODY OR BUMPER



CARRIER & BASE
FLUSH MOUNTED ON
VEHICLE BODY OR BUMPER

FIGURE 5

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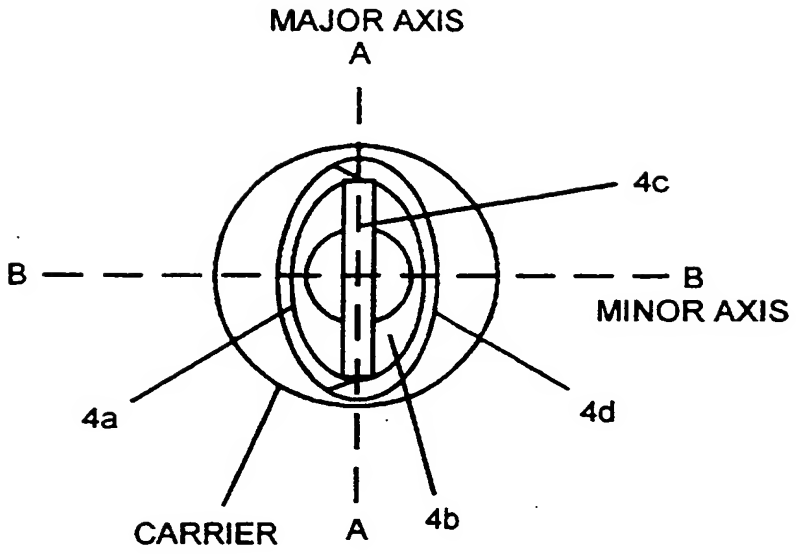

FRONT VIEW OF CARRIER

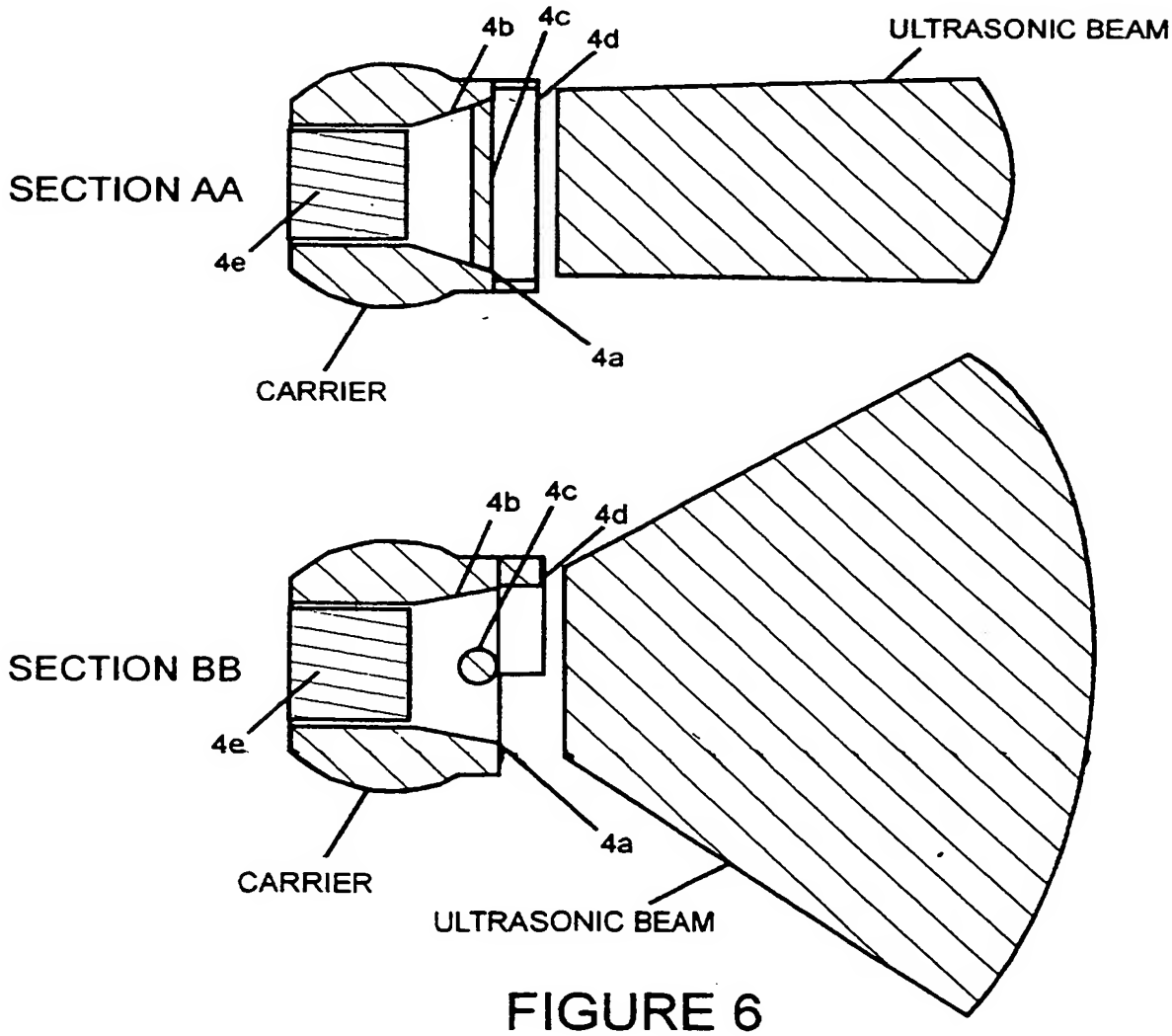

FIGURE 6

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ULTRASONIC OBJECT DETECTION SYSTEM

This invention relates to a Ultrasonic Object Detection System for use on a motor vehicle.

Systems using ultrasonic devices for detection of objects in a vehicle's pathway are known. These systems use a plurality of sensors spaced at a known separation on the vehicle, allowing precise readouts of an object's distance from said sensors. The known separation is directly related to the type of vehicle the system is fitted to. A disadvantage inherent in the known systems is that they have to be set up with a precise separation between the sensors, and/or sensors to ground, the setup involving complex adjustments and/or component changes to the control circuitry.

The present invention aims at improving the above mentioned known systems. Certain embodiments of this invention may need no complex adjustments, therefore no prior knowledge of the target vehicle's dimensions are required allowing this flexible system to be installed first and calibrated in use and subsequently installed to different vehicles throughout its life time with out the need for the pre-mentioned complex adjustments.

The invention provides apparatus for use on a motor vehicle to give an indication of the distance of the vehicle from an object being approached by the vehicle,

which apparatus is defined in the appended claims. The invention further provides methods of operating and setting up such apparatus, also defined in the claims.

One preferred embodiment of apparatus constructed in accordance with the invention uses a microprocessor based system with permanent and temporary memory, executing a complex real-time program. When using a single ultrasonic transmitter transducer spaced at an unknown distance from a single ultrasonic receiver transducer, the time lag can be determined between a transmitted pulse from the ultrasonic transmitter transducer and receipt of this pulse directly from the ultrasonic transmitter transducer to the ultrasonic receiver transducer, incurring no reflections due to the directivity pattern of the unique shaped carriers that the ultrasonic transmitter transducer and ultrasonic receiver transducer are housed in. This measured time lag can be represented by a calculated value and stored temporarily or permanently, with the power supply being removed or permanent. This stored value is used subsequently to determine the exact distance of an object from the ultrasonic sensors, these distances are then divided into known zones which represent arcs from the centre line of the vehicle's body figure 2, these zones being converted into audio tones representing each zone arc, so as an object passes or resides in a particular zone, that audio tone or multiple of tones are repeated until the object moves out of a

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zone into another.

Another preferred embodiment of apparatus constructed in accordance with the invention uses a microprocessor based system with permanent and temporary memory, executing a complex real-time program, which when using a single ultrasonic transmitter transducer spaced at an known distance from a single ultrasonic receiver transducer, uses a selection of stored values which represent distances between transmitter and receiver, these being chosen using a multi-way switch.

DETAILED DESCRIPTION

By way of example only, one specific embodiment of distance detecting system and the method on which that system operates will now be described in detail, reference being made to the accompanying drawings, in which:-

Figure 1 is a block diagram of an ultrasonic detector system with accordance with the present invention.

Figure 2 shows fragmentary plan and side elevational views of a motor vehicle fitted with the ultrasonic transmitter and receiver.

Figure 3 shows the direction of movement of the carrier in the base.

Figure 4 shows a detailed sectional view of the carrier.

Figure 5 shows two example embodiments of the carrier and

base.

Figure 6 shows detailed sectional views of the carrier and resulting beam pattern.

As shown in figure 1, a distance determining system according to the present invention comprises of a central microprocessor 1 which controls the frequency and duration of the ultrasonic pulses, the microprocessor is locked to a reference crystal oscillator 2.

The microprocessor generates the ultrasonic frequencies to be transmitted then amplified by the driver circuit 3, this range of ultrasonic frequencies are transmitted one frequency at a time, at alternate pulse transmissions in a known frequency band, this eliminates the known effect of superposition, due to reflected ultrasonic waves combining and cancelling resulting in nulls. For example the use of two ultrasonic frequencies, frequency A and frequency B, frequency A is transmitted and then processed before frequency B, then frequency B is transmitted and then processed. This alternate transmitting of the two frequencies maintains constant ultrasonic echoes if an object is present because one frequency may cancel showing no object present the other will show the object being present, the reason being the ultrasonic echoes reflected from an object may cancel to a null before the echoes are received by the ultrasonic receiver transducer, this then indicates no object present, but when frequency B is transmitted, the

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frequency change alters the ultrasonic echoes reflected from the object and so this time they do not cancel being of different wavelength, thus the ultrasonic receiver transducer receives the echoes and the system processes the echoes as an object is present.

The ultrasonic transmitter transducer is situated in a ball like carrier and in turn this carrier is connected to a base as defined in the appending claims, this facilitates movement in the vertical plane and movement in the horizontal plane as figure 3 shows. The carrier has an oval mouth 4a which is part of a oval tube 4b. The transmitter ultrasonic wave travels down the oval tube 4b to the open end of the oval mouth 4a, this oval shape narrows the ultrasonic beam in the major axis of the oval which is disposed vertically Figure 4.

The ultrasonic transmitter transducer of diameter D is mounted in the carrier at the position 4e shown in Figure 6 with the front of the ultrasonic transmitter transducer at a defined distance in the preferred range of 0.5 times D to 2 times D from the oval mouth 4a open end. By situating the ultrasonic transmitter transducer in the preferred range of 0.5 times D to 2 times D from the oval mouth open end the required beam shape can be achieved in both the horizontal plane and vertical plane. One example of this distance which gives advantageous results is 0.75 times D. The ultrasonic transmitter transducer is situated in the carrier with the length of the major axis of the oval mouth 4a as shown in Figure 6 in the

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preferred set of ratios from 0.9 to 0.5 to the length of the minor axis of the oval mouth 4a. One example of this ratio of major axis to minor axis which gives advantageous results is 0.75, producing the required ultrasonic beam pattern being narrow in the vertical plane and wide in the horizontal plane as shown in figure 6. The ultrasonic receiver transducer of diameter D is mounted in the carrier at the position 4e shown in Figure 6 with the front of the ultrasonic receiver transducer at a defined distance in the preferred range of 0.5 times D to 2 times D from the oval mouth 4a open end. By situating the ultrasonic receiver transducer in the preferred range of 0.5 times D to 2 times D from the oval mouth open end the required beam shape can be achieved in both the horizontal plane and vertical plane. One example of this distance which gives advantageous results is 0.75 times D. The ultrasonic receiver transducer is situated in the carrier with the length of the major axis of the oval mouth 4a as shown in Figure 6 in the preferred set of ratios from 0.9 to 0.5 to the length of the minor axis of the oval mouth 4a. One example of this ratio of major axis to minor axis which gives advantageous results is 0.75, producing the required ultrasonic beam pattern being narrow in the vertical plane and wide in the horizontal plane as shown in figure 6. The bar 4c as defined in the appended claims spreads the ultrasonic waves in the horizontal plane by means of reflection and dispersion. The ultrasonic beam is further shaped by the

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tapering cross-sectional 4d area towards the mouth 4a as defined in the appended claims which cuts off the beam in the direction of the cross-sectional area 4d as shown in figure 4. The overall effect of the carrier is to produce a beam which is wide in the horizontal plane, but narrow in the vertical plane as shown in figure 2 and figure 6. Figure 5 shows two example embodiments of the carrier and base, one being flush mounted, the other surface mounted.

The ultrasonic receiver transducer 6 is mounted in an identical carrier to the ultrasonic transmitter transducer 5 having the same beam shape characteristics insuring only ultrasonic echoes from the target region are received as shown in figure 2. This ultrasonic receiver transducer receives the ultrasonic energy reflected from an object, this signal is then amplified in the receiver circuit 4. The receiver circuit 4 comprises of an amplifier, a band-pass filter, a detector and a variable level comparator circuit and schmitt trigger circuit. This variable level is directly controlled by the microprocessor to obtain a variable gain to detect objects of different sizes and at different ranges. The signals from the receiver circuit 4 go directly to the microprocessor 1 for validation. A valid echo results in the microprocessor 1 sending out an alarm signal corresponding to the zone the echo was received in, this signal enters the alarm circuit 7, the alarm circuit 7 has the ability to directly output the

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alarm signal to an audible sounder or led display 8 or both. An additional example of embodiment of apparatus constructed in accordance with the invention uses a Radio frequency or Infra red transmitter, system 9 to relay the alarm signal from the microprocessor 1 to the Radio frequency or Infra red receiver system 10 which may be located several metres away from the microprocessor 1, located in a cab for example of commercial vehicle such as an articulated lorry without the need for extra wires connecting microprocessor 1 to the remote alarm unit 10. The remote alarm unit 10, consists of the necessary receiver circuity for the above transmission system used and an audible sounder and/or a display of a purity of Leds denoting the zones of the system.

One preferred method of setup and operation as defined in the appended claims is described as follows:

To set up the system the ultrasonic transmitter carrier and ultrasonic receiver carrier mounted on the vehicle should be directed towards each other as defined in the appended claims. The Control Switch 11 is then switched to the setup/calibration mode and the distance between the transmitter and receiver is measured as the shortest time interval between transmission of a signal and a receipt of the same by the receiver. This time interval is stored and subsequent transmission and return signals are calibrated from this stored value. The control switch can now be returned to normal operation position.

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Another example method of setup uses other preferred embodiment of apparatus constructed in accordance to the invention where the control switch selects a selection of stored time intervals which relate to the separation between the transmitter and receiver on different vehicles. The transmitter and receiver carriers can now return to an outward pointing direction so to cover the area as shown in figure 2, as the carrier mounted to the base facilitates movement as shown in figure 3.

The ultrasonic receiver then receives an ultrasonic echo from an object, this pulsed signal has to be of the correct frequency as the transmitter pulse and be of a correct amplitude for detection in the receiver circuit, depends on what distance it is from the sensors the swept gain controlled by the microprocessor allows progressively low amplitudes of the received signal to be detected as the distance between objects and the transmitter and receiver increases. This allows smaller and more distance objects detection as well as large objects at the same distance. Once the pulsed signal leaves the receiver circuit, the microprocessor 1 measures the pulse width of the signal and rejects pulses in relationship to the known transmitted duration. If the pulsed signal is accepted, its position in time with respect to the calibrated value derived on setup is converted to a zone as in figure 2, the microprocessor decides which zone the object is in and sends an alarm signal to the alarm circuit 7. The alarm signal is made

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up of a multiple of tones each representing a different zone arc, for example three zones arc as in figure 2. The alarm circuit may also transmit the state of the alarm to a remote alarm unit 10.

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CLAIMS

1. Apparatus for use on a motor vehicle to give an indication of the distance of the vehicle from an object being approached by the vehicle, which apparatus comprises a signal transmitter and a receiver for receiving signals emanating from the transmitter and following the refection thereof from said object, the transmitter and receiver being adapted for mounting on the vehicle in a spaced apart disposition, and control means to provide a drive signal to the transmitter and to detect and analyze the output of the receiver and provide a distance indication dependent thereon, the transmitter and the receiver each being provided in a respective carrier which carrier has an open mouth with the transmitter or receiver as appropriate being directed out of the mouth, the mouth being generally of oval shape and adapted for mounting with the major axis of the oval disposed vertically.

2. Apparatus as claimed in claim 1, wherein a bar extends across the mouth substantially on the major axis of the oval shape.

3. Apparatus as claimed in claim 2, wherein the carrier defines a cavity between the transmitter or the receiver as appropriate and the mouth, a portion of the cavity adjacent the mouth being of tapering cross-sectional area towards the mouth.

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4. Apparatus as claimed in any of claims 1 to 3, wherein each carrier is connected to a base adapted for mounting on the vehicle, the connection between each carrier and its base being in the form of a ball and socket joint.

5. Apparatus as claimed in claim 4, wherein the base is in the form of a housing within which the greater part of the respective carrier is supported.

6. Apparatus for use on a motor vehicle to give an indication of the distance of the vehicle from an object being approached by the vehicle, which apparatus comprises a signal transmitter and a receiver for receiving signals emanating from the transmitter and following the refection thereof from said object, the transmitter and receiver being adapted for mounting on the vehicle in a spaced apart disposition, and control means to provide a drive signal to the transmitter and to detect and analyze the output of the receiver and provide a distance indication dependent thereon, the control circuit being adapted to supply a drive signal to the transmitter at a frequency which varies with time.

7. Apparatus as claimed in claim 6, wherein the control circuit is arranged to reject signals detected by the receiver which do not correspond to the frequency of the transmitted signal.

8. Apparatus as claimed in claim 6 or claim 7, wherein the control circuit provides a series of drive signal pulses, each such pulse being at a frequency different

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from the frequency of the immediately previous pulse.

9. Apparatus as claimed in claim 8, wherein the control circuit is arranged to provide pulses at two different frequencies.

10. Apparatus for use on a motor vehicle to give an indication of the distance of the vehicle from an object being approached by the vehicle, which apparatus comprises a signal transmitter and a receiver for receiving signals emanating from the transmitter and following the refection thereof from said object, the transmitter and receiver being adapted for mounting on the vehicle in a spaced apart disposition, and control means to provide a drive signal to the transmitter and to detect and analyze the output of the receiver and provide a distance indication dependent thereon, the mounting of the transmitter and receiver on the vehicle permitting the transmitter and receiver when so mounted to be directed towards each other, and the control circuit having a set-up mode to permit the detection of the spacing of the transmitter and receiver when directed as aforesaid, which said detected spacing is used in any subsequent analysis of a received signal when the transmitter and detector are directed normally.

11. Apparatus as claimed in claim 10, wherein the control circuit, when in the set-up mode, utilises the shortest time interval between transmission of a signal and the receipt of the same by the receiver for determining said spacing.

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12. Apparatus for use on a motor vehicle to give an indication of the distance of the vehicle from an object being approached by the vehicle, which apparatus comprises a signal transmitter and a receiver for receiving signals emanating from the transmitter and following the refection thereof from said object, the transmitter and receiver being adapted for mounting on the vehicle in a spaced apart disposition, and control means to provide a drive signal to the transmitter and to detect and analyze the output of the receiver and provide a distance indication dependent thereon, the transmitter and the receiver each being provided in a respective carrier, each carrier being connected to a base adapted for mounting on the vehicle, the connected between each carrier and its base being in the form of a ball and socket joint.

13. Apparatus as claimed in claim 12, wherein the base is in the form of a housing within which the greater part of the respective carrier is supported.

14. Apparatus for use on a motor vehicle to give an indication of the distance of the vehicle from an object being approached by the vehicle and substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

15. A method of operating apparatus for use on a motor vehicle to give an indication of the distance of the vehicle from an object being approached by the vehicle, the apparatus including a spaced apart signal transmitter

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and a receiver for receiving signals emanating from the transmitter and following the reflection thereof from said object, in which method a drive signal is supplied to the transmitter and the output of the receiver is detected and analyzed to provide a distance indication dependent thereon, the drive signal supplied to the transmitter being at a frequency which varies with time.

16. A method as claimed in claim 15, wherein detected signals from the receiver which do not correspond to the frequency of the transmitted signal are rejected during the analysis thereof.

17. A method as claimed in claim 15 and claim 16, wherein a series of drive signal pulses are supplied to the transmitter, each such pulse being at a frequency different from the frequency of the immediately previous pulse.

18. A method as claimed in claim 17, wherein pulses at two different frequencies are supplied to the transmitter.

19. A method of setting up apparatus for use on a motor vehicle to give indication of the distance of the vehicle from an object being approached by the vehicle, the apparatus including a spaced apart signal transmitter and a receiver for receiving signals emanating from the transmitter and following the reflection thereof from said object, and a drive signal is supplied to the transmitter and the output of the receiver is detected and analyzed to provide a distance indication dependent

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thereon, in which setting up method the transmitter and the receiver when mounted on the vehicle are directed towards each other, a drive signal is supplied to the transmitter and the analysis of the signal detected by the receiver determining the spacing of the transmitter and receiver, the determined spacing being stored for use in any subsequent analysis of a received signal when the transmitter and detector are directed normally.

20. A method as claimed in claim 19, wherein analysis of the received signal to determine the spacing of the transmitter and receiver when setting-up the apparatus utilises the shortest time interval between transmission of a signal and the receipt of the same by the receiver.

21. A method of setting-up and/or operating apparatus for use on a motor vehicle to give an indication of the distance of the vehicle from an object being approached by the vehicle and substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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The Patent Office

Application No:	GB 9718824.7	**Examiner:**	Peter Easterfield
Claims searched:	1 to 5	**Date of search:**	12 January 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): G1G (GRE); H4D (DRPC); H4X (X3)

Int Cl (Ed.6): G01S 15/93; G10K 11/00, 11/02, 11/26, 11/28

Other: Online: WPI, JAPIO, CLAIMS

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	GB 2279745 A	(GEC-MARCONI) see fig.3 & p.6 ll.5-17	1, 3
Y	GB 2272819 A	(ROBERT BOSCH) see p.5 ll.13-24	1, 3
Y	GB 2160321 A	(NISSAN) whole document	1, 3
Y	GB 1565258 A	(MATSUSHITA) whole document	1, 3

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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